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Abstract

The Reactor Installation of the Research Vessel of Kernenergie-Gesellschaft

by

W. Wiebe, Gesellschaft für Kernenergieverwertung Geesthacht
König, Arbeitsgemeinschaft Babcock-Interatom
I. Weisbrodt, Arbeitsgemeinschaft Babcock-Interatom

The research vessel of the "Gesellschaft zur Verwertung von Kernenergie in Schiffbau und Schiffahrt" (GKSS), Hamburg, was ordered at the Howaldtswerke, Kiel, in November 1962, and will be launched about April 1964. The reactor for this ship, ordered at the beginning of 1964 from the associated group of Babcock and Interatom, is an advanced type of a pressure water reactor, operating under saturation conditions at a reduced primary pressure of 63 ata, and being designed according to the integrated system.

The requirements for ship-reactors of any type are far more severe than for stationary installations. The available space is restricted and weight has to be saved as far as possible. In spite of this it is necessary to dimension the strength of all parts of the reactor and its supports for additional forces from acceleration. Under all movements of the ship at sea the operation must be reliable and the working of all safety devices without fail. As moreover a ship may be exposed to accidents like collision, grounding, capsizing, and sinking, it must be assured that even under such condition the reactor will not become a source of dangerous consequences.

The research vessel is over a certain length of the hull, the so-called reactor zone, reinforced by a special collision protection and a higher double-bottom. One compartment of this zone houses the containment built as a vertical cylindrical vessel which is supported from double-bottom and bulkheads in a statically determined way. While on the N.S. "Savannah" the containment is a horizontal cylinder requiring a greater length, the reactor compartment is here of square section. The secondary shielding which on the N.S. "Savannah" covered the containment is here applied on the surrounding bulkheads. Thus it is possible to inspect the whole containment from the outside. A further characteristic of the reactor, described later on, will permit even inspections on the inside.

Forward of the reactor compartment proper lies another compartment for supplementary installations and furthermore a shielded compartment for storage of burnt-up elements, i.e. an integrated service station.

The containment can be entered through an air lock and has several flooding flaps for pressure equalizing in case of sinking. Inside the containment the pressure vessel takes a central position within a shield water tank containing the primary shielding. The pressure vessel encompasses the complete primary cooling system including the heat exchangers. Only the three primary circulating pumps are on the outside being connected to nozzles. The integral construction, entirely different from the system used on the N.S. "Savannah" is a marked progress in several respects:

1. By the lack of outside fittings from primary coolant like pipe-lines, heat-exchangers and shut-off valves,

2. by improved safety against collision and radiation effects, and further

3. by the lower operating pressure of 63 ata as against 123 ata for the N.S. "Savannah".

There are some more advances in relation to the N.S. "Savannah" installation: All decontamination is performed inside the containment; the number of control rods is reduced from 21 to 12, the number of fuel elements from 32 to 16; the electric operating power is essentially lower; the primary circulating pumps are of the simple propeller type; the mounting and accessibility is substantially improved; there are three independent heat exchangers instead of two; safety and control devices are much simplified; an accident by uncontrolled access of cold water is impossible.
The primary circuit inside the pressure vessel passes through the core in the lower center position upwards within a chimney toward the surface of the water, and returns through the annulus between chimney and wall of the vessel. The upper part of this annulus contains the tube-bundle system of the heat exchanger. The control rods penetrate the cover of the pressure vessel and are operated from the outside. In addition to the three pump nozzles in the bottom there are three feedwater-inlet and three steam-outlet nozzles in the cylindrical portion of the pressure vessel. The heat exchanger is working in the once-through principle and delivers slightly superheated steam of 30 ata.